

# **Display Developer for Firing Room Applications**

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# Display Developer for Firing Room Applications

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The firing room at Kennedy Space Center (KSC) is responsible for all NASA human spaceflight launch operations, therefore it is vital that all displays within the firing room be properly tested, up-to-date, and user-friendly during a launch. The Ground Main Propulsion System (GMPS) requires a number of remote displays for Vehicle Integration and Launch (VIL) Operations at KSC. My project is to develop remote displays for the GMPS using the Display Services and Framework (DSF) editor. These remote displays will be based on model images provided by GMPS through PowerPoint. Using the DSF editor, the PowerPoint images can be recreated with active buttons associated with the correct Compact Unique Identifiers (CUIs). These displays will be documented in the Software Requirements and Design Specifications (SRDS) at the 90% GMPS Design Review. In the future, these remote displays will be available for other developers to improve, edit, or add on to so that the display may be incorporated into the firing room to be used for launches.

## Nomenclature

CUI	= Compact Unique Identifier
DSF	= Display Services and Framework
GMPS	= Ground Main Propulsion System
GSDO	= Ground Systems Development and Operations
ILOA	= Integrated Launch Operations Applications
IT	= Information Technology
KSC	= Kennedy Space Center
LCC	= Launch Control Center
LCS	= Launch Control System
NASA	= National Aeronautics and Space Administration
SLS	= Space Launch System
SRDS	= Software Requirements and Design Specification
VAB	= Vehicle Assembly Building
VIL	= Vehicle Integration and Launch

## I. Introduction

Remote displays for the firing rooms are necessary in order to control launch procedures for NASA human spaceflight. It is important that these displays are properly tested, up-to-date, and user-friendly; the slightest mistake could be the difference between life and death for crew members on-board. For this project, I developed remote displays for the Ground Main Propulsion System (GMPS) at NASA Kennedy Space Center (KSC).

## II. Background Information

It is helpful to learn about certain aspects that molded this project in order to better understand why display development is important. The displays I created in this project are for the Ground Main Propulsions System (GMPS), a subsystem within Ground Systems Development and Operations (GSDO). The displays were created through the Display Services and Framework (DSF) editor with Integrated Launch Operations Applications (ILOA), and will be used for Vehicle Integration and Launch (VIL) Operations at KSC.

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## **A. Ground Systems Development and Operations (GSDO)**

The Ground System Development and Operations (GSDO) Program's purpose is to develop and use the complex equipment required to safely handle rockets and spacecraft during assembly, transport, and launch. Unlike previous work focusing on a single kind of launch vehicle such as the Saturn V rocket or space shuttle, engineers and managers in GSDO are preparing infrastructure to support several different kinds of spacecraft and rockets that are in development [1].

GSDO supports a number of projects, including NASA's Space Launch System (SLS) and Orion Multi-Purpose Crew Vehicle. The SLS is set to be the most powerful U.S. rocket since the Saturn V took astronauts to the moon, and will act as the cornerstone for NASA's future human space exploration. Orion will carry the astronauts who will be launched into space on the SLS. In support of the SLS, launch pad 39B, the crawler-transporter, Vehicle Assembly Building (VAB), the Launch Control Center's (LCC) Firing Room 1, and the new mobile launcher (ML) are undergoing modifications for their new roles [1].

## **B. Ground Main Propulsion System (GMPS)**

The Ground Main Propulsion System (GMPS) is designed to safely and accurately perform the processes required by the SLS core stage (CS) and upper stage (US) Integrated systems. During ground operations the primary function of the GMPS is to manage the CS and US main propulsion systems and their associated GMPS Ground Support Equipment (GSE) during all phases of integration, testing, propellant loading, terminal count, and any associated contingency operations. The GMPS key functions are to safely and efficiently manage and distribute the CS and US hydrogen and oxygen cryogenic propellants, and to provide the Core Stage Engines (CSE) with nitrogen and helium purging as required supporting CSE operations [2].

## **C. Vehicle Integration and Launch (VIL)**

The Vehicle Integration and Launch (VIL) team is an important part of GSDO, as they focus on the equipment, management, and operations required to safely connect a spacecraft with a rocket, move the launch vehicle to the launch pad, and successfully send it into space. The work entails use of many of the facilities unique to KSC, such as the 52-story VAB, the dual launch pads 39A and B, and the 3-mile-long runway at the Shuttle Landing Facility [1].

## **D. Integrated Launch Operations Applications (ILOA)**

The main role of Integrated Launch Operations Applications (ILOA) is to provide tools and resources that enable the subsystem engineering community to develop the spacecraft, launch vehicle, and ground support equipment subsystems checkout and launch application software that executes within the end to end command and control system. It is the responsibility of ILOA remote display developers to create user interfaces that are installed in the firing room. These displays are created using the ILOA development environment: Display Support Framework (DSF) Editor provided by the Launch Control System (LCS) running in a Linux Virtual Machine (VM) [3].

# **III. Project Phases**

Before I could begin developing any displays, certain technical training had to be under taken and Information Technology (IT) security and account approvals had to be obtained. Once these steps were taken, I was assigned to the GMPS subsystem and my work began on remote displays through the DSF Editor.

## **A. Technical Trainings**

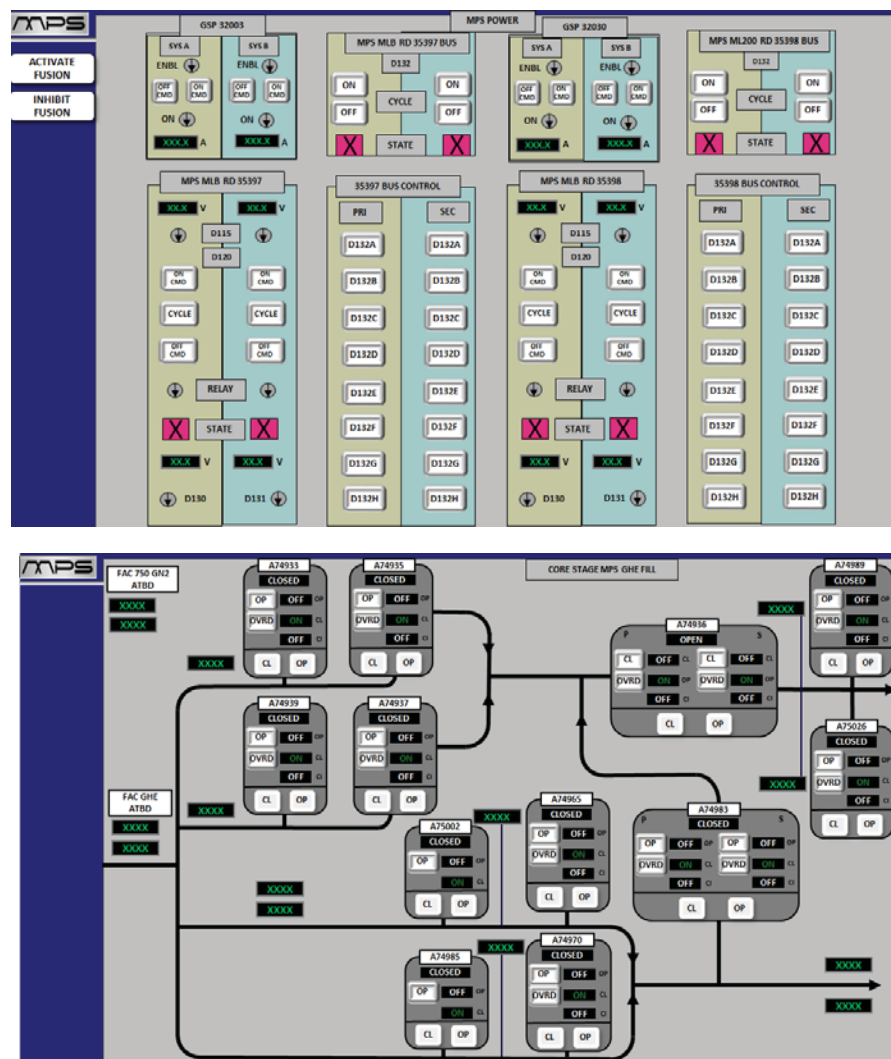
Upon arrival as an intern at KSC, the first step was to undergo much technical training. These trainings involved software requirements, ILOA, the LCS display editor, Application Control Language (ACL) programming, software testing, and ILOA specific AccuRec training [3]. A great deal of information was cultured, and all of this technical training has come in handy throughout my internship.

## **B. IT Approvals**

Along with the technical training, many IT approvals had to be obtained before work could begin with the DSF editor. IT Approvals that were necessary to support ILOA include a KSC Design Data Management System (KDDMS) account to manage and control KSC subsystem design documents; Enhanced Integrated Collaborative Environment (ICE) to function as a launching point for numerous online NASA collaboration tools; ILOA Share Drive to share documents and status among ILOA support personnel; ClearQuest to track new software development and to track bugs found in existing software; LCS Development (LCSDEV) Domain to function as a logon environment that is used to develop remote ILOA software products; AccuRev as a software configuration management tool; and X-Win32 to allow remote connections to a Linux based machine [3]. These IT approvals took a great deal of time to acquire, but all were necessary before I could begin with display development.

### C. Display Services and Framework (DSF) Editing

Upon receiving all of the essential IT approvals, assignment to a specific subsystem could occur and the display development process could begin. The GMPS subsystem presented eight PowerPoint images of displays that they would like to be created through DSF. Figure 1 shows two of the provided PowerPoint images:



[Figure 1]

Using the DSF, I recreated these images to become user interfaces. The development process is much like the procedures to create a display in PowerPoint, Paint, etc. However when created in the DSF, Compact Unique Identifiers (CUIs) can be associated with command buttons and state commands to communicate that a specific

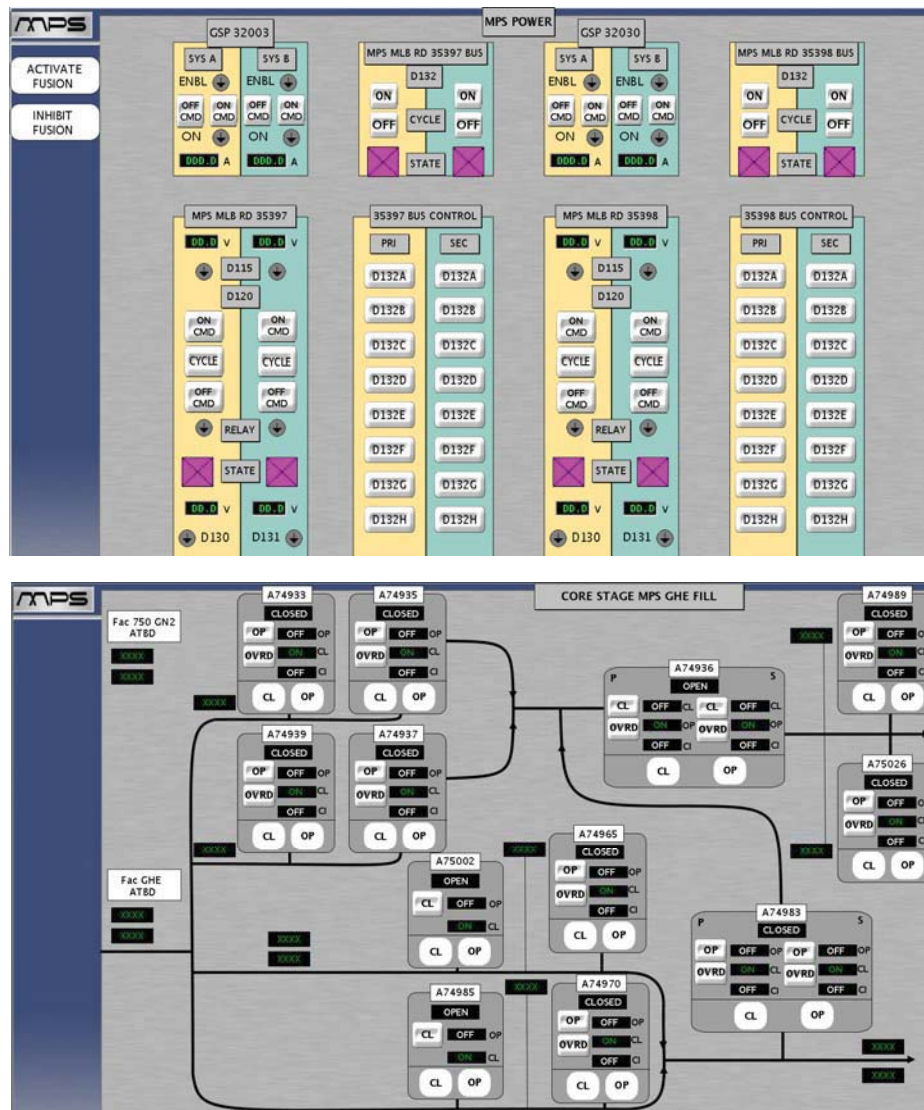
action be triggered. Once the appropriate CUIs have been created, they will be linked with the correct command buttons and the remote displays can be tested and eventually implemented into the LCC.

## IV. Results

As a result of this project, eight displays have been developed for GMPS to use in their Software Requirements and Design Specifications (SRDS) for their 90% Design Review, and eventually these displays will be implemented into the LCC for future launches.

### A. Final Products

Figure 2 shows screen captures of two GMPS displays developed through the DSF that correspond to the PowerPoint templates shown in Figure 1:



[Figure 2]

I have developed eight displays based on the GMPS PowerPoint images. At this point the displays are not functional due to the appropriate CUIs not yet being created.

### C. Continuation and Future Use

Work will continue on these GMPS displays through the duration of my internship. I will work on improvements to make these user interfaces as easy to navigate as possible. My background in human factors engineering makes this task ideal for me. Potential enhancements I will focus on include setting specific colors for boxes based on if they are primary or secondary functions, constructing buttons that light up green when activated, and creating more space for new boxes that may be implemented in the future.

Once improvements have been made to the displays' structure and appearance, they will be included in the GMPS SRDS to demonstrate what the displays integrated into the firing room will look like. When the proper CUIs have been created, the CUIs will be associated with the appropriate command buttons, and the displays will then be ready for testing.

These remote displays will be available for other developers to edit or add on to as GMPS discovers more requirements for the displays. The final versions of the displays will eventually be implemented in the LCC to be used for future launches of the next generation of rockets, such as SLS.

### V. Conclusion

NASA human spaceflight launches could not take place without the displays located in the LCC and their underlying control logic. These displays enable engineers to control every move in a launch. It is imperative that these displays be properly tested, up-to-date, and user-friendly. My project focused on the displays that will be used by GMPS for VIL operations at KSC. In the future, the displays developed in this project will experience improvements, have appropriate CUIs associated with command buttons, be used in the GMPS 90% Design Review SRDS report, and hopefully be integrated into the LCC to be used for upcoming launches.

This internship has been an amazing learning experience. The opportunity to study under such intelligent civil servants and develop displays that could potentially be used for the launch of SLS has been unforgettable. KSC is rich in history, and it has been an honor to work at such an incredible place that does such brilliant work.

### Acknowledgments

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